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Racial Disparity in Cardiac Procedures and Mortality Among Long-Term Survivors of Cardiac Arrest

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Background—It is unknown whether white and black Medicare beneficiaries have different rates of cardiac procedure utilization or long-term survival after cardiac arrest.

Methods and Results—A total of 5948 elderly Medicare beneficiaries (5429 white and 519 black) were identified who survived to hospital discharge between 1990 and 1999 after admission for cardiac arrest. Demographic, socioeconomic, and clinical information about these patients was obtained from Medicare administrative files, the US census, and the American Hospital Association's annual institutional survey. A Cox proportional hazard model that included demographic and clinical predictors indicated a hazard ratio for mortality of 1.30 (95% CI 1.09 to 1.55) for blacks aged 66 to 74 years compared with whites of the same age. The addition of cardiac procedures to this model lowered the hazard ratio for blacks to 1.23 (95% CI 1.03 to 1.46). In analyses stratified by race, implantable cardioverter-defibrillators (ICDs) had a mortality hazard ratio of 0.53 (95% CI 0.45 to 0.62) for white patients and 0.50 (95% CI 0.27 to 0.91) for black patients. Logistic regression models that compared procedure rates between races indicated odds ratios for blacks aged 66 to 74 years of 0.58 (95% CI 0.36 to 0.94) to receive an ICD and 0.50 (95% CI 0.34 to 0.75) to receive either revascularization or an ICD.

Conclusions—There is racial disparity in long-term mortality among elderly cardiac arrest survivors. Both black and white patients benefited from ICD implantation, but blacks were less likely to undergo this potentially life-saving procedure. Lower rates of cardiac procedures may explain in part the lower survival rates among black patients. **(*Circulation*. 2003; 108:286-291.)**

Key Words: heart arrest ■ prognosis ■ survival ■ aging

More than 340 000 cardiac arrests occur annually in the United States, and 90% of patients are older than 65 years of age.[1] Among the 2% to 21% of patients who survive,[2] the relationship of race to long-term mortality is poorly understood. Findings vary in previous studies of race and short-term survival after cardiac arrest. Differences in survival to hospital discharge were found between whites and blacks in Chicago, Ill,[3] but no such disparity was observed in suburban Michigan.[4] Although sizable registries of long-term survivors have been compiled in clinical trials,[5,6] these may not reflect survival in the general population. Blacks have a higher incidence of cardiac arrest,[7] yet the largest community-based survival study was conducted in a population with fewer than 2% nonwhites.[8,9] Other survival studies in localities such as Rotterdam, the Netherlands, or Seattle, Wash, had very few black patients.[10,11]

Racial disparity in revascularization for coronary artery disease is the subject of several reports.[12,13] Some investigators have noted that lower revascularization rates among black patients were accompanied by reduced long-term survival.[12] With mounting evidence that implantable cardioverter-defibrillators (ICDs) can improve survival after cardiac arrest,[6] the annual number of implants has increased substantially.[14] It is unknown whether there is a racial difference in the likelihood that cardiac arrest survivors will receive ICDs. In the present study, we examined Medicare records to assess whether there is racial disparity in the use of life-saving procedures after cardiac arrest and whether differences in procedure rates may contribute to black-white differences in long-term mortality.

Methods

The primary data sources were Medicare Provider Analysis and Review (MEDPAR) administrative records from a random 20% selection of all Medicare beneficiaries from 1990 to 1999. We established a cohort of long-term survivors who were hospitalized with an admission diagnosis of ventricular fibrillation or cardiac arrest (International Classification of Diseases, Ninth Revision, Clinical Modification codes 427.4, 427.41, and 427.5) and survived to discharge. Admission diagnosis was a selection criterion to preserve the sequence between the presenting cardiac arrest and subsequent procedures performed during the index hospitalization and to minimize the number of patients with cardiac arrest as a complication of medical care. All patients were white or black, aged

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66 years or older, and admitted to nonfederal hospitals through emergency departments.

Exclusion Criteria

After forming the initial cohort, we excluded patients with any prior ventricular fibrillation, cardiac arrest, electrophysiological study, or ICD implantation. Exclusion criteria included ambiguous date of death, uncertain discharge destination, noncontinuous Medicare enrollment, absence from the Medicare enrollment database, or Medicare coverage for less than 1 year before the index admission (these records were used to assess comorbidity). Because the US census and the American Hospital Association were sources of linked data, we removed patients who resided in ZIP codes for which census data were unavailable or who were admitted to nonparticipating hospitals in the American Hospital Association's annual institutional survey.

Demographic Variables

Demographic information was abstracted from the Medicare enrollment database; herein, age and gender were determined from birth record documentation used in Social Security applications, whereas race was self-reported. Because preliminary analyses revealed a nonlinear effect of age on survival, we modeled age as a binary categorical variable in which patients were classified as younger or older than 75 years; this divided our cohort into approximately equal halves. Because socioeconomic factors can influence the relationship between quality of health care and outcomes,[15] we estimated educational attainment and income by matching the subject's race and ZIP code to race-specific median education and per capita income as reported, by ZIP code, in the 1990 census. Income was adjusted for regional variation in cost of living.[16] Although ZIP code data cannot accurately estimate the socioeconomic status of individuals, such data have been used effectively in prior studies to control for socioeconomic variation among communities.[17] We determined Medicare Part B and health maintenance organization (HMO) enrollment from the Medicare enrollment database. Using American Hospital Association survey data, we identified characteristics (eg, academic affiliation) of each admitting hospital.

Preexisting Diagnoses and Comorbidities

The index MEDPAR record was linked with all Medicare records for hospitalization and outpatient medical care that occurred within 1 year before the index admission. Preexisting coronary artery disease (codes 410 to 411) and congestive heart failure (CHF; code 428) were determined from these records. To risk-stratify patients for noncardiac comorbidity, we used Romano's adaptation of the Charlson index to assign a comorbidity score to each subject.[18,19]

Index Hospitalization Variables

Medical events during the index hospitalization, such as admission for ventricular fibrillation (versus cardiac arrest) or any coding for acute myocardial infarction (AMI; code 410), cardiac ischemia (411), CHF (428), or anoxic brain injury (348.1), were obtained from the index MEDPAR record. Length of stay and discharge destination were also abstracted. Because the Medicare population and the effectiveness of therapies likely changed over the period from 1990 to 1999, we included year of admission in our models to control for time trends. Because patients who receive procedures may also benefit from related aspects of medical care (eg, access to specialists) that could lower mortality, we used a 20% sample of MEDPAR records from 1990 to 1999 to identify institutions performing ICD implantation and/or revascularization during a particular year. We thereby designated patients as having been admitted to an ICD hospital and/or a revascularization hospital.

Outcomes

The primary outcome of interest, all-cause mortality, was determined from the annual Medicare enrollment database, which was cross-referenced to the Social Security Death Master File. Patients present in the 1999 enrollment database without a death indicator were censored at December 31, 1999. Patients without a death indicator who did not appear in the 1999 database were censored at the termination date for Medicare Part A coverage. The dates of ICD implantation (procedure codes 37.94 or 37.96), percutaneous coronary intervention (36.0), and CABG (36.1) were determined from the index and all subsequent MEDPAR records through 1999.

Multivariate Survival Analyses

We constructed 3 multivariate Cox proportional hazard models. The proportional hazard assumption was confirmed statistically for all variables[20] except anoxic brain injury; all models were subsequently stratified on this factor. The first model incorporated race, age, gender, income, education, region, metropolitan size, HMO or Medicare Part B enrollment, admission year, comorbidity index, preexisting CHF or coronary artery disease, admission diagnosis of ventricular fibrillation, AMI, acute ischemia without infarction, acute CHF, acute anoxic brain injury, admission to an ICD hospital or revascularization hospital, length of stay, and discharge destination. Interactions between race, gender, age, and comorbidity were also included. Our second model added coronary revascularization as a time-dependent covariate. The final model included ICD implantation as an additional time-dependent covariate.

Cardiac Procedures

To assess the effect of race on cardiac procedure utilization, we constructed multinomial logistic regression models using predictors that significantly differed between whites and blacks in univariate analysis (ie, race, gender, age, region, income, education, admission year, comorbidity index, ventricular fibrillation on admission, acute ischemia without infarction, AMI, acute CHF, academic hospital admission, and discharge destination) and interactions between age, gender, race, and comorbidity. The 3 potential outcomes were (1) survival to 90 days after index admission without receiving a procedure, (2) death before 90 days without a procedure, and (3) receipt of procedure within 90 days of admission. We separately analyzed ICD implantation and receipt of either ICD implantation or coronary revascularization.

Statistical Analyses

We used *t* tests to compare continuous variables except when data were skewed, in which case logarithmic transformation or the Wilcoxon rank-sum statistic was used. Categorical variables were compared with the χ^2 test or Fisher exact test. Comparisons between the values of coefficients in nested multivariate models followed the method of Clogg et al,[21] with Bonferroni correction for multiple pairwise comparisons. All analyses were performed with SAS version 8.2. (SAS Institute). All significance tests were 2-sided. We assumed a probability value of less than 0.05 was statistically significant.

Results

Characteristics of the Study Cohort

A total of 7131 patients were identified initially. Of these, 1183 (17%) were subsequently excluded (Figure 1). There was no statistically significant difference between the proportion of whites or blacks excluded. Among the 5948 patients ultimately included, the proportion of males was significantly higher among whites than among blacks (Table 1). Black patients lived in ZIP codes with lower levels of income and education. Blacks also had significantly more comorbidity, with higher rates of CHF, diabetes, hypertension, anemia, and renal disease. Whites were more likely to be admitted for ventricular fibrillation and to be diagnosed with AMI, cardiac ischemia, or acute CHF. Black patients were more likely to be admitted to an urban or major teaching hospital. Whites were more likely to be discharged home.

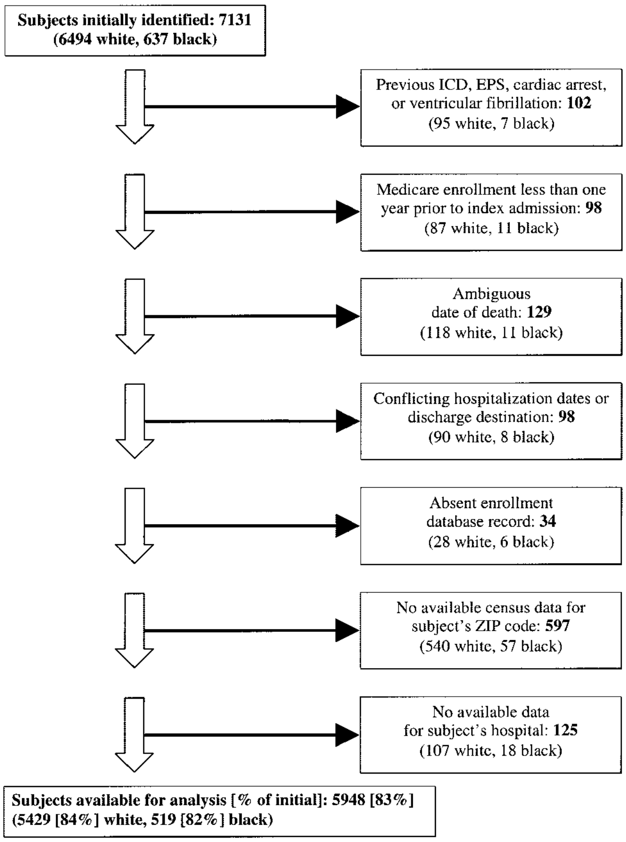

Figure 1. Exclusion criteria applied to patients hospitalized for cardiac arrest or ventricular fibrillation and discharged alive. Block arrows represent successive application of exclusion criteria. Line arrows indicate numbers of excluded patients, stratified by race. EPS indicates electrophysiological study.

Outcomes

The patients were followed up for a median of 4.8 (interquartile range 2.4 to 7.8) years. By December of 1999, 2970 patients (50%) had died, and 2244 (38%) were confirmed alive. The remaining 734 patients (12%) were censored at a median of 3.3 (interquartile range 1.9 to 5.3) years after the index admission. There was no significant difference in the proportion of whites and blacks censored before the end of 1999. ICDs were implanted in 820 survivors (14%), of whom 780 were white and 40 were black. Coronary revascularization was performed in 716 survivors (12%), including 682 whites and 34 blacks.

Unadjusted Analyses

The unadjusted survival rate was significantly lower among blacks (Figure 2). A total of 48% of all patients survived at least 4 years after hospital discharge, yet life expectancy for whites (4.1 years) was significantly longer than for blacks (1.9 years; $P<0.0001$ by log-rank test).

Adjusted Survival Analyses

In multivariate analyses, significant interaction was observed between age and race ($P=0.0003$) but not between race and gender ($P=0.68$) or between race and comorbidity ($P=0.78$). Models that controlled for demographic, clinical, and hospital factors indicated no survival difference between whites and blacks older than 75 years (Table 2). In contrast, higher mortality risk for younger blacks persisted despite control for these covariates. The addition of coronary revascularization and ICD implantation to the model resulted in a significant decrease in the hazard ratio (HR) for younger blacks from 1.30 to 1.23 ($P<0.0001$ for the difference).

Cardiac Procedures

Survival analyses stratified by race indicated that ICD implantation was independently associated with reduced long-term mortality among both black (HR 0.50, 95% CI 0.27 to 0.91) and white (HR 0.53, 95% CI 0.45 to 0.62) patients. In contrast, coronary revascularization was associated with lower mortality among whites (HR 0.48, 95% CI 0.40 to 0.57) but not among blacks (HR 1.32, 95% CI 0.76 to 2.29). More than 90% of ICD patients underwent implantation within 90 days of admission. Younger patients were nearly twice as likely as older patients to receive procedures. In multivariate models that examined procedure rates, interaction was not observed between race and age ($P=0.15$), race and gender ($P=0.84$), or race and comorbidities ($P=0.71$). Blacks aged 66 to 74 years were significantly less likely to receive an ICD by 90 days than whites (OR 0.58, 95% CI 0.36 to 0.94). For the combined outcome of ICD implantation or coronary revascularization by 90 days, younger blacks again had substantially lower odds than whites of receiving at least 1 procedure (OR 0.50, 95% CI 0.34 to 0.75). No racial differences were noted in ICD implantations or in combined procedure rates among patients aged 75 years and older.

Discussion

Among elderly survivors of cardiac arrest, blacks aged 66 to 74 years have a lower probability of receiving potentially life-saving cardiac procedures and have reduced long-term survival. These disparities persist despite adjustment for socioeconomic differences, comorbidities, admission characteristics, clinical events, and hospital factors. In fact, a substantial portion of the remaining survival disparity may be explained by the differing procedure rates; the observed change in HR for younger blacks suggests that 7% of excess adjusted mortality might be attributable to underuse of procedures. Because mortality rates among cardiac arrest survivors are generally high, increasing use of cardiac procedures among younger blacks may save several additional lives per year.

The present study identifies a substantial racial disparity in the clinical use of effective and common medical technologies. Although this analysis was not designed to determine the causes of such disparity, previous investigators have identified patient preferences, mistrust, patient-provider communication, cultural issues, provider bias, and systemic inequities as potential contributors to racial disparities in medical care.[15]

ICD implantation may be more clinically appropriate if ventricular fibrillation can be determined as the cause of cardiac arrest; conversely, implantation may be less appropriate in the setting of evolving myocardial infarction.[22] Although younger blacks had fewer documented episodes of cardiac ischemia and ventricular fibrillation than whites, our

TABLE 1. Baseline Characteristics of the Cohort*

	Whites (n=5429)	Blacks (n=519)	*P*
Demographic characteristics			
Age, mean (SD), y	76 (7)	76 (8)	NS
Female gender	2157 (40)	318 (61)	<0.0001
Per capita income, median (IQR), $	13 700 (11 600–16 800)	12 300 (9900–14 900)	0.0001
Education, mean (SD), y	13.7 (1.3)	12.3 (1.1)	<0.0001
Region			<0.0001†
Northeast	1240 (23)	83 (16)	
Midwest	1518 (28)	145 (28)	
South	1526 (28)	243 (47)	
West	1145 (21)	48 (9)	
Admitted 1995–1999	2565 (47)	253 (49)	NS
HMO‡	266 (5)	28 (5)	NS
Medicare Part B‡	4991 (92)	465 (90)	NS
Clinical characteristics			
Comorbidity index, median (IQR)	0 (0–1.2)	1.2 (0–2.4)	<0.0001
Selected comorbidities§			
Anemia	478 (9)	100 (19)	<0.0001
CHF	1680 (31)	205 (39)	<0.0001
Coronary artery disease	1136 (21)	112 (22)	NS
Diabetes without complications	617 (11)	111 (21)	<0.0001
Diabetes with complications	64 (1)	30 (6)	<0.0001
Hemiplegia/paraplegia	34 (1)	12 (2)	0.0004
Hypertension	1034 (19)	171 (33)	<0.0001
Metastatic cancer	51 (1)	16 (3)	0.001
Renal disease	191 (4)	78 (15)	<0.0001
Index hospitalization			
Admitted for ventricular fibrillation	1290 (24)	82 (16)	<0.0001
Myocardial ischemia or infarction	2212 (41)	143 (28)	<0.0001
Acute CHF	2367 (44)	202 (39)	0.04
Anoxic brain injury	1501 (28)	124 (24)	NS
Length of stay, median (IQR)	11 (7–18)	12 (8–20)	NS
Population, hospital location			<0.0001†
≤100 000	959 (18)	72 (14)	
100 001–500 000	1391 (25)	115 (22)	
500 001–1 000 000	815 (15)	79 (15)	
>1 000 000	2264 (42)	253 (49)	
Academic hospital‖	768 (14)	137 (26)	<0.0001
ICD hospital¶	1561 (29)	163 (31)	NS
Revascularization hospital¶	2698 (50)	276 (53)	NS
Discharge destination			
Home	4362 (80)	386 (74)	0.003†
Skilled nursing facility	740 (14)	97 (19)	
Intermediate-care facility	327 (6)	36 (7)	

IQR indicates interquartile range.

*Unless otherwise indicated, data appear as number (percentage).

†*P* for χ^2 of distribution among categories.

‡Enrolled during index hospitalization.

§Other Charlson comorbidity categories with no significant racial differences.

‖Member of the Council of Teaching Hospitals.

¶Hospital reported performing procedure during year subject was admitted.

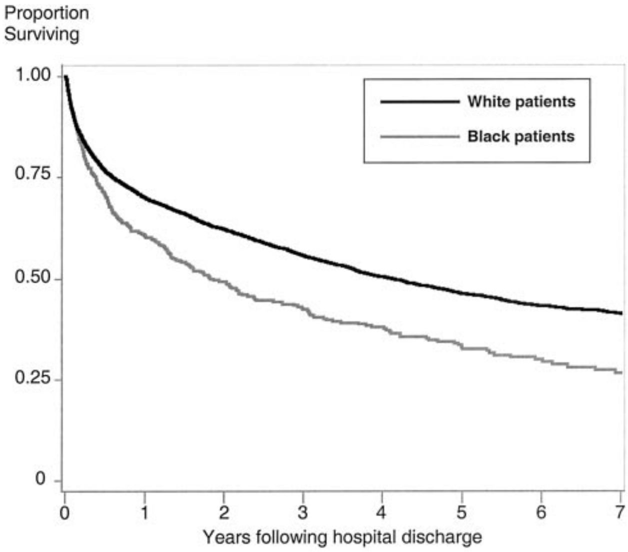

Figure 2. Unadjusted Kaplan-Meier survival estimates for black and white cardiac arrest survivors. The *y*-axis is proportion of cohort surviving at time from cardiac arrest indicated on *x*-axis.

multivariate analyses, which controlled for both factors, showed persistent racial disparities. The present study excluded patients with the admission diagnosis of ventricular tachycardia, yet fewer than 2% of out-of-hospital cardiac arrest patients have ventricular tachycardia.[23]

To our knowledge, this was the first nationally representative cohort of cardiac arrest survivors assembled in the medical literature. The 10-year enrollment period enabled precise estimation of life expectancy and the pattern of survival. We enrolled substantial numbers of black patients, which was essential in identifying race as a risk factor for both lower procedure rates and early mortality. Our multivariate models controlled for multiple demographic, socioeconomic, and clinical factors that might confound the association between race, survival, and procedure utilization. Because ICDs are increasingly recognized as first-line therapy for cardiac arrest survivors, our results highlight the importance of eliminating barriers to procedure utilization among blacks.

TABLE 2. Effect of Race on Long-Term Survival: Hazard Ratios from Multivariate Analyses

Age, y	HR*	95% CI	P
Demographic and clinical variables only			
66–74	1.30†	1.09–1.55	0.003
≥75	0.88	0.74–1.06	0.18
Plus revascularization			
66–74	1.28†	1.07–1.52	0.006
≥75	0.85	0.71–1.02	0.08
Plus ICD implantation			
66–74	1.23†	1.03–1.46	0.02
≥75	0.86	0.72–1.03	0.10

*Mortality HR for blacks compared with whites in same age strata.
†Differs significantly ($P<0.001$) from corresponding HR in prior model.

The present study is also the first to find comparable clinical benefit of the ICD in both black and white survivors. Therefore, increasing ICD utilization among appropriate black patients may improve health outcomes. The finding that revascularization was not associated with prolonged survival among blacks may simply be a reflection of small sample size (only 34 black patients [6.5%] underwent revascularization), or it may represent differences in the causes of cardiac arrest among blacks and whites. The difference in gender proportions between whites and blacks is possibly due to the "selection effect" of cardiac arrest, which may reduce survival in patients with worse general health (eg, elderly black men). Regardless, our multivariate models controlled for gender directly and in interaction with other variables; thus, the racial disparities we observed cannot be explained by differences in gender proportion.

Comparisons With Prior Cardiac Arrest Studies

The Cardiac Arrest Study Hamburg trial followed 288 survivors of cardiac arrest who were assigned to either ICD implantation or antiarrhythmic drug therapy.[6] The 4-year mortality rate was 31%, which was substantially lower than the 52% we observed. The selective entry criteria for such clinical trials complicate the application of results to the general population. The present population-based study is more likely to reflect the outcomes experienced by the majority of elderly American cardiac arrest survivors. In their cohort analysis, Cobbe et al[8] noted that 56% of 321 cardiac arrest survivors over the age of 65 years remained alive at 4 years, which was similar to the 48% 4-year survival rate that we observed. The present study broadens these findings with its greater capacity to examine the effect of race on clinical outcomes.

Comparisons With Prior Racial Disparity Studies

Previous studies of ICDs and racial disparity used California hospital discharge abstracts from the early 1990s to demonstrate that blacks may receive fewer procedures.[24,25] The present study extends these findings by focusing on a high-risk cohort (cardiac arrest survivors) by use of a national sample, recording procedures from throughout the 1990s, and following patients for a substantially longer duration.

Data Limitations

Some comorbidities may be underreported or unobservable in administrative records. If blacks had disproportionately more unreported comorbidity than whites, this may explain lower procedure rates and reduced survival among blacks, as well as the larger reduction in mortality due to ICDs noted in the present study (47% to 50%) compared with clinical trial results (25% to 30%).[5,6] However, we used a well-validated method for risk adjustment of administrative data, and we found no interaction between observed comorbidity and race, as would be expected if comorbidity were underestimated for blacks. Furthermore, all patients in the clinical trials received efficacious treatments, and differences in efficacy were assessed in intention-to-treat analyses. The present analysis, which compared survival among actual ICD recipients to all those who did not receive ICDs, would therefore be expected to yield a larger treatment difference.

The present study used administrative data, which can be less accurate than medical records or data from prospective clinical trials. Administrative data are insufficiently detailed to precisely identify contraindications to ICD use; however, because these are closely correlated to the cardiac diagnoses and comorbidities incorporated in our models, we believe any bias introduced by racial differences in contraindications would be minimal. Although we could not validate our data with medical records, MEDPAR data have been found to be reliable for major medical diagnoses and procedures,[26] and racial disparity studies using administrative data have frequently found results comparable to those that used clinical databases.[13] We also used aggregate measures of education and income; residual differences among individuals may have confounded our results. Additionally, patients who received cardiac procedures may have been admitted to higher-quality hospitals. However, inclusion of variables indicating the technological capacity of the admitting hospital did not weaken the association between the actual procedures and survival, as would be expected if differences in healthcare quality, rather than procedures, produced the survival disparity. Finally, the observation that our mortality HR for younger blacks remained at 1.23 in our full survival model suggests that we did not account for all possible factors related to both race and mortality; indeed, factors such as health-related behaviors or patient preferences were unobservable. It is possible that the inclusion of such variables could diminish the observed effect of procedures on mortality.

Design Limitations

Because this was an observational study, the association we found between lower procedure rates and survival may not necessarily be causal. Yet, because the number of nonwhites surviving cardiac arrest is not large, an observational analysis with a large national database may be the only feasible method of examining racial differences in healthcare outcomes. Finally, because all patients in the present study were black or white and over the age of 65 years, caution should be exercised in applying the results outside of this population.

Conclusions

Blacks aged 66 to 74 years do not live as long after cardiac arrest as white patients. Some of this disparity can be explained by differential rates of cardiac procedures such as revascularization and ICDs. This result, combined with racial disparity in the use of ICDs in younger but not older Medicare beneficiaries, implies that expanded use of effective procedures in black patients would substantially reduce racial differences in long-term survival.

Acknowledgments

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